Developing A General Practice Medical Workstation: The Integration Aspect

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ABSTRACT

ISAAC (Integrated System Architecture for Advanced Primary Care) is a project aiming at developing information technology and telematic support in the specific field of General Practice - and more broadly in the Primary Health Care sector - within the health care systems of different European Countries. The project aims at improving the work of the General Practitioners through the development of a useful and usable medical workstation for day-to-day patient care. Moreover ISAAC has the goal of prototyping an integration architecture for the improvement of the communications between the ISAAC workstation and heterogeneous application environments, namely other components of the health care system. This paper deals with a general description of the design along with a discussion of the adopted approach to fulfill the integration requirements.

BACKGROUND

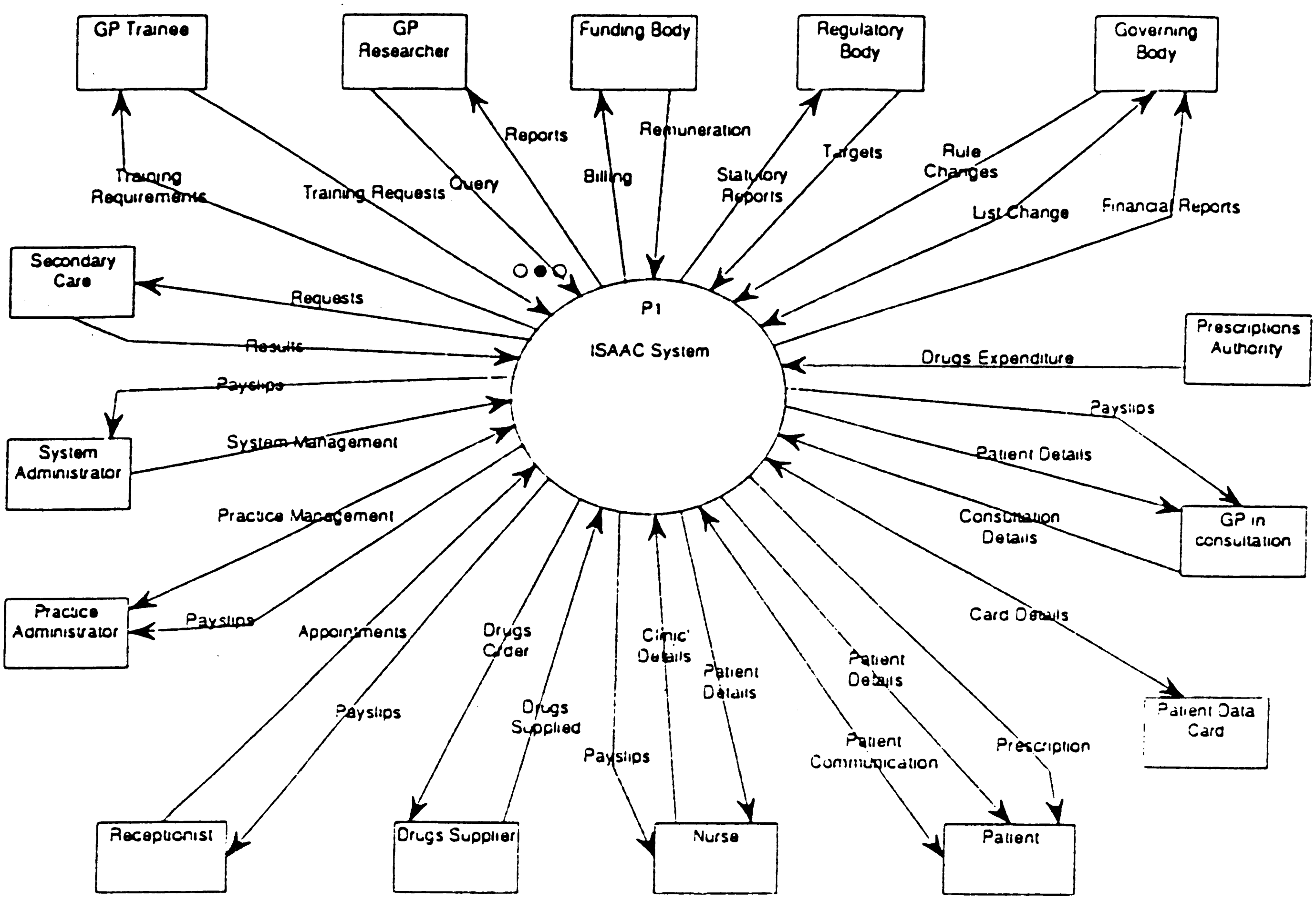
Comparative cross-national studies of health care systems have a long history, while few of them have provided a more focused information analysis related to the role played by actors in the primary care sector [1]. The Primary Health Care (PHC) is being given a great importance in Health Systems world-wide. Primary care workers are spread throughout the community and are often working in cultural and geographic isolation. The latter is especially true in rural areas. The General Practitioner (GP) is at the hub of PHC activity and in most European countries he/she acts as "gate-keeper", the crucial interface between primary and secondary care. The relationship between the GP and the patient is one of first contact, its hallmarks the continuity of care and the holistic approach. A GP deals with the day-to-day management of patient, tackling a wide range of conditions. The development of primary care oriented, computer-based patient record has been an active area of research during the past years [2,3,4]. A recent study by the Institute of Medicine argues that most of the technological barriers that have impeded the development of computer-based patient record are disappearing [5] along with an overcoming of cultural impeding factors [6].

DESIGN CONSIDERATIONS

A Functional Reference Model (FRM) concerning General Practice has been obtained by collecting data from several European countries defining the role of GPs in their National Health Care Systems. The results of the survey has led to a functional structuring and a rational and homogeneous grouping of GP activities. To take into account the needs of modularity and to satisfy national differences, this activities have been clustered into a set of functional areas. These areas cover a range of issues which define the basic tasks for implementing European Primary Health Care information and communication technology systemsThe project team is working on the comparison of the FRM with other models valid at national level, namely the Dutch and English models [7,8].

In the ISAAC workstation the computer-based patient record is designed to be the centerpiece of a comprehensive information system addressing diverse requirements of patient care, research, prevention, patient/GP education, local population monitoring, outside reporting and financial management.

To realize the abstract model of this system supporting the requirements of Primary Care, a Global Architecture has been defined based upon the ANSA methodology [9]. This methodology looks at the system in terms of views (Enterprise, Information, Computational, Engineering and Technology Projections) each describing a different aspect of the system. In the context of the enterprise projection, the ISAAC context Diagram (fig.1) establishes the boundary between the ISAAC system and the environment. It shows the data flow between the system and its terminators (shown has rectangles in the diagram). A terminator may be any other system or users that produces or receives information from our system. In the context of the information projection, the conceptual data model is produced



ISAAC Context Diagram

following an object-oriented approach. It is represented by means of an Entity Attribute Relationship Model (EAR) of which the more commonly used Entity Relationship Diagram (ERD) is a component.

INTEGRATION FEATURES

As has become increasingly evident, GPs are requiring to access information and services provided by other institutions in simpler and faster ways than the actual ones. Other health care providers are also experiencing the need and demand increasing amounts of information: the need for integration within the Health Care System is thus well-established [10]. Here by integration we mean the true electronic exchange of information in the sense of interoperability, that is interchange of information without the "user" having to understand, interpret or transform information.

Within ISAAC an Integration Systems Architecture (ISA) has been designed. The aim of this architecture is that of presenting to the GP all the services which he can access using a common environment. It will allow the GP to customize the working environment to suite his own needs, to set up default parameters and security measures, and to access other services of the system such as running any available application and, especially, the integration with remote systems.
The architectural design can be considered in four main sections:
1 - Logging onto the system: each user who intends to use the system will have to be identified. This identification will be used for the audit trail and for allocating system privileges
2 - Applications and local ISAAC database: several applications will be available. All of these applications will have access to the ISAAC database and, where possible, will support Object Linking and Embedding (OLE)

3 - Outputting information and messages from the system: when outputting information, other than to the local database, all applications will go through an Output Control module. This will determine the destination of the information and perform any necessary switching, formatting or auditing action.
4 - Receiving and handling incoming messages: incoming messages will be received by the communication modules and sent to the Incoming Message Handling module. This will ensure that messages are read and dealt with appropriately as soon as possible.
Points 3 and 4 are described in detail in the following paragraphs.

Integration with remote systems

To exchange information with different institutions in Health Care Systems means the integration of several architectures and of different applications running on distributed and heterogeneous environments.
Architectures include every possible configuration ranging from personal workstations to local networks, minis, mainframes, etc. (fig. 2).

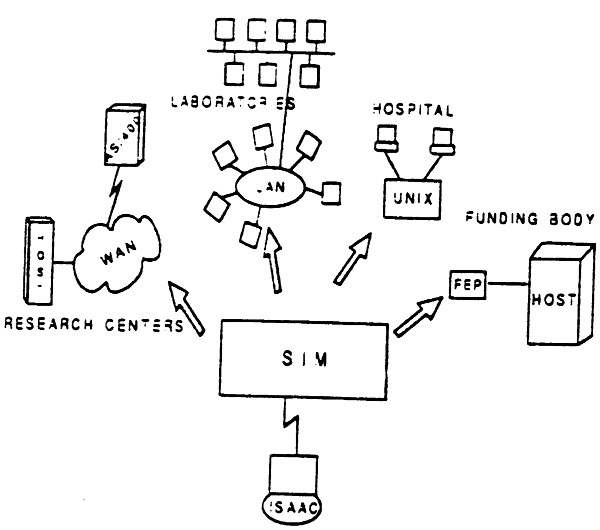


Fig. 2 Integration Scenario

All these architectures may use different technologies, different types of connection, different system software, different graphics capabilities, different data management, etc. Local solutions can be interconnected in complex patterns, through local and/or geographic connections, an endless number of possible configurations.
Applications have followed a similar line of development: local solutions have been developed first. Later, the need to cooperate with other applications, locally or remotely located, arose. Cooperation sometimes may simply imply the possibility of exchanging data between two different applications [11]. More often functional integration must be achieved, where application A needs that operation X is performed by application B. This usually involves the sending of input parameters from application A to application B to activate the operation and the returning of output parameters from application B to application A as the result of the operation.
Current technology provides basic tools to integrate different heterogeneous applications, but the process for doing this is still rather rudimentary and expensive. Functional integration is mostly solved developing complex and expensive ad-hoc procedures that are used as interfaces.
The proposed solution starts from the analysis of the current situation in the health care field throughout different European countries. No standard has really been adopted and even in countries where standardization policies have been mandated by governments, the degree of homogeneity among different health care providers is very low [12,13,14].
The overall aim of the Integration System Architecture is to allow the integration of remote applications with the ISAAC Workstation in a way that is transparent to the GP. Transparency in ISAAC means that the GP should only select the type of message, the data to be sent, and the institution (hospital, lab, etc.) to which the message must be sent. This releases him from having to consider a number of low-level communication details and, most of all, isolates him from the heterogeneity of the integrated systems.
An important concept used in the design of the ISA is that of non-intrusive which is opposite to the one described above - the integration of heterogeneous systems only through the definition of ad-hoc interfaces. This commonly used approach means that specific - not standard - procedures and modules have been added to existing applications or systems. In the health care field this solution is not feasible due to the great heterogeneity of the systems - too many modules should be defined. In ISAAC a non-intrusive application is an application that does not need specific modules on the remote system, but can access applications acting as a normal remote user of the application. Due to the differences among applications, several kinds of interaction have been identified. They are described in the following paragraphs.
This kind of integration is possible due to a "flexible and intelligent interface", named Services Integration Manager (SIM) - see Fig. 2 - that translate GP's requests into the format specific to the target Information System. The SIM module, which is a part of the ISA, is located between the ISAAC

Workstation and the remote applications. Each GP can access one SIM and several GPs can access the same SIM. There exist several SIMs distributed on the territory each connecting a specific set of GPs with a specific set of remote institutions. SIMs are connected with each other creating a network capable of connecting GPs with each other and providing GPs access to a wide number of institutions.

The SIM is in charge of

1. collecting requests sent by GPs,
2. routing them to the correct recipient,
3. matching arrived responses with originating requests, and
4. managing the resending of messages not yet sent due to different problems - line busy, remote application not ready, etc.

The SIM thus performs part of the functionality of the Output Control module and implement the asynchronism between the GP and the remote applications. The other functionality of the Output Control module are performed by a module which is local to the ISAAC Workstation. This module maintain information and implement the functionality required to:

- extract the data requested for the invoked service,
- prepare the message to be sent, and
- send the prepared message to the SIM connected with the GP.

The GP is not aware of the procedures carried out by the Output Control module: he/she simply chooses the service, the recipient and checks if the extracted data are correct and complete.

Responses are sent to the ISAAC Workstation by the SIM when the GP requests them. The Incoming Message Handling module stores them in a specific directory allowing the GP to examine them before including received data in the local medical database. The GP can also delete messages without including their data in the medical DB.

The proposed solution creates consistent and reusable basic tools, in order to cope with the most outstanding problems:

a. the heterogeneity of physical architectures and devices

b. the heterogeneity of communication standards and protocols

c. the integration, at functional level, of applications, data and messages, which has been independently developed.

Problems 'a' and 'b' are solved through the creation of libraries of modules (object) which cover most of the cases that can be found currently in European Health Care Information System.

The libraries, which will cover most of the interesting cases, are easily extensible, since they are based on the Object-Oriented approach.

Problem 'c' will be solved with a library of special modules, Communication Logical Views (CLV), Data Logical Views (DLV) and Transfer EDI Messages (TEM).

These modules, managed by a SIM's specific layer, allow the definition of powerful mappings, direct access to remote data, and the execution of EDI conversion.

CLV Certain applications, like the ones which can be on mainframes, can only be accessed through the invocation of a CLV. Communication Logical Views, unlike the DLV described in the next paragraph, are implemented using the concept of Virtual Operator: the SIM acts as a human operator who seats in front of a real terminal and interacts with the application. The SIM sends the correct sequence of commands and data to the remote application in order to fulfill the request invoked by the GP. The remote application sends, as response to the commands, video screens as if it is communicating with a real terminal. The CLV module then extract the requested information from the video screen. Since standard access facilities provided by remote applications are used, preexisting security policies can not be violated.

DLV Data Logical Views are used when the remote application accesses a relational database. After the connection has been established, the DLV module sends query or update commands to the remote database receiving, as response, sets of data and operations outcome (success, failure, etc.).

TEM The Transfer EDI Messages module allows the exchange of messages written using the EDIFACT syntax. This module prepares the message that has to be sent in the format requested by the specific EDI Translator used by the ISAAC Workstation: different translators can be used according to different requirements.

The modules described so far can not cover all the possible situations, e.g. a real-time connection with a poison center, but since this architecture is a modular one, new modules can be added thus covering new areas.

Since these modules should not be used directly by the GP but should instead activated automatically by other parts of the workstation, all the information needed to complete the requested operations should have been stored somewhere sometime. This information comes from a survey carried out for the Functional Reference Model. ISAAC has studied the communications between GPs and other health care entities (funding bodies, hospitals, laboratories, etc.) to identify the real needs of GPs in terms of data exchange, health care providers involved, type of communication, etc.. The result summarizes the communication requirements of GPs in several countries and actually reduced the number of possible configurations. Thus, given this defined set of messages, exchanged data, and entities involved, it is possible to create procedures needed for the integration.

CONCLUSIONS

The work carried out in the definition of the ISAAC workstation has highlighted the level of heterogeneity which exists in the field of Primary Care throughout several European countries. Differences exist not only at technical level but also at functional level. Even though commonalties can be found in the activities carried out by GPs, the current practice reflect the cultural and organizational differences between national and regional health care organizations.

With this project we address the need of integration between Primary and Secondary Care providers in order to improve the quality of care across Europe, decentralize health care, reduce hospitalization and, as a consequence, reduce health care expenditures.

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